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FERRELLS, PLLC
A Virginia Professional Corporation
Practice Limited to Intellectual Property Matters

Michael William Ferrell
4400 Fair Lakes Court
Suite 201
Fairfax, Virginia 22033-3899

Telephone: 703-968-8600
Facsimile: 703-968-5500
E-mail: mike@ferrellaw.com
Website: www.ferrellaw.com

March 10, 2006

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Re: *Request for Certificate of Correction* for
United States Patent No. 6,932,753 B1
Issued August 23, 2005
Bruce R. Smith et al.
Entitled *Food Serving Paperboard Container Pressing Apparatus Employing Cast-In Electrical Heaters*
Our Reference No. 12165 (GP-03-8)

Sir:

Attached hereto is a proposed *Certificate of Correction* in the above-noted patent, together with the attached sections of the patent wherein the errors are highlighted thereon.

Please issue a *Certificate of Correction* pursuant to 35 USC 254 to correct these mistakes, some of which occurred through the fault of the United States Patent and Trademark Office and some of which occurred through Applicant's mistakes. All corrections are of a typographical nature and are believed appropriate subject matter for a *Certificate of Correction*.

Please charge Deposit Account No. 50-0935 for any fees in connection with this matter.

Respectfully submitted,

MW Ferrell

Michael W. Ferrell
Reg. No. 31,158

MWF/crm
Attachments

CERTIFICATE OF MAILING BY FIRST CLASS MAIL (37 CFR 1.8)

Applicant(s): **Bruce R. Smith et al.**

Docket No.
013550-069(12165;GP-03-8)

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PATENT & TRADEMARK OFFICE

Patent No.	Issue Date	Examiner	Customer No.	Group Art Unit
6,932,753	August 23, 2005	E. Kim	40256	3721

Invention: **FOOD SERVING PAPERBOARD CONTAINER PRESSING APPARATUS EMPLOYING CAST-IN ELECTRICAL HEATERS**

I hereby certify that this <u>Letter, Cert. of Correction, pages from issued patent and return postcard</u>
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is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to "Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450" [37 CFR 1.8(a)] on

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MAR 21 2006

(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,932,753 B1

DATED : August 23, 2005

INVENTOR(S) : Bruce R. Smith et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In Col. 1, line 32, insert --.-- after "inexpensive";
In Col. 3, line 25, delete "difficulties" and insert --difficulty--;
In Col. 5, line 32, insert --to--after "mounted";
In Col. 6, line 2, delete "ter" and insert --heater--;
In Col. 8, line 48, delete "person" and insert --persons--; and
In Col. 15, line 27, delete "provides" and insert --provide--

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MW Ferrell

PATENT NO. 6,932,753 B1

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Michael W. Ferrell, Esq. - Reg. No. 31,158
Ferrells, PLLC
P.O. Box 312, Clifton, Virginia 20124-1706
Telephone: 703-968-8600
Facsimile: 703-968-5500

MAR 21 2006

FOOD SERVING PAPERBOARD CONTAINER PRESSING APPARATUS EMPLOYING CAST-IN ELECTRICAL HEATERS

This application is based on and claims priority under 35 U.S.C. §119(e) with respect to U.S. Provisional Patent Application No. 60/111,568 filed on Dec. 9, 1998.

FIELD OF THE INVENTION

The present invention generally relates to a pressing apparatus for forming food service paperboard articles. More particularly, the present invention pertains to an apparatus for press forming food service paperboard container products such as plates, bowls, trays and platters.

BACKGROUND OF THE INVENTION

U.S. Pat. Nos. 4,721,500, 4,609,140, 4,721,499, 5,088,640, 5,326,020, 4,832,676 and 4,606,496 describe processes and apparatus for forming food service paperboard container products such as paper trays, plates and the like from a paperboard blank, and food service paperboard container products formed from such processes and apparatus. The patents describe that the paperboard blank is formed into the desired paperboard container product through use of a pressing apparatus that applies heat and pressure to the paperboard blank.

The apparatus typically used in the disclosed process includes an upper die and a lower die. In practice, both the lower die and the upper die are heated by a heating mechanism in the form of one or more electrically resistive ring heaters. Ring heaters are commonly used because they are relatively inexpensive. Typically, the lower die is provided with a pair of nested ring heaters or a single ring heater, while the upper die is outfitted with either a pair of nested ring heaters or a single ring heater, depending upon the particular product being formed. Quite often, the heat requirements related to the way in which the paperboard container products are formed necessitate that at least two ring heaters be provided in both the upper die and the lower die.

FIG. 1 illustrates a pair of nested ring heaters similar to those used in the apparatus for press forming paperboard blanks into paperboard container products. As can be seen from FIG. 1, the pair of nested ring heaters includes an annular outer ring heater **60** and an annular inner ring heater **62**, with the inner ring heater **62** being nested within the outer ring heater **60**. The pair of nested ring heaters **60, 62** is fitted inside a cavity in the lower die. As mentioned above, the upper die can be provided with a similar pair of nested ring heaters, or it can be outfitted with only a single ring heater, depending upon the requirements of a particular system.

Ring heaters can be purchased as off-the-shelf items from a suitable supplier. However, to produce food service paperboard articles in the manner described in the aforementioned patents, significantly high temperatures are required and this necessitates that the ring heaters possess a very high wattage. Thus, for these applications, it is typically necessary to special order the ring heaters having the desired wattage, as well as the desired size, voltage and/or terminations.

As can be further seen from FIG. 1, the outer ring heater **60** includes a pair of terminals **70** and the inner ring heater **62** also includes a pair of terminals **72**. Typically, the terminals **70** on the outer ring heater **60** are connected to the power source, and an electrical connection is then made between the pair of terminals **70** on the outer ring heater **60** and the pair of terminals **72** on the inner ring heater **62**.

It has been found that a cold spot (lower temperatures) typically exists in the region of the terminals **70, 72** due to the terminal connections which means that a cold spot will also exist in the die in the region of the pressing surface corresponding to the locations of the terminals **70, 72**. Thus, to avoid a cold spot in the die and provide generally uniform heating around the entire circumference of the heater mechanism defined by the pair of ring heaters **60, 62**, it is desirable that the pair of terminals **70** on the outer ring heater **60** be offset 180° with respect to the pair of terminals **72** on the inner ring heater **62**. In practice, this has been found to be somewhat problematic in that the wire that connects the pair of terminals **70** on the outer ring heater **60** to the pair of terminals **72** on the inner ring heater **62** can run excessively hot in the enclosed die cavities, resulting in wire insulation degradation and failure due to the wires shorting to ground. Thus, it is common in practice to position the inner and outer ring heaters **60, 62** in the manner illustrated in FIG. **1** so that the terminals **70, 72** can be connected together with an electrical buss bar or the like. This connection is not susceptible to the same type of failure mentioned above. However, this orientation of the two ring heaters **60, 62** creates a cold spot at the place where the terminals **70, 72** are located. This thus creates a temperature differential around the circumference of the die. By virtue of this arrangement of the nested ring heaters **60, 62**, it has been found that a temperature differential of up to approximately 30° F.–40° F. can exist between the portion of the die forming surface corresponding to the location of the terminals **70, 72** and the diametrically opposite portion of the die forming surface that is offset 180°. From the standpoint of carrying out the method described in the aforementioned patents, this temperature differential can be quite significant and rather problematic.

It has also been found that the wires used to connect the outer ring heater **60** to the power source have a tendency to break. It is believed that this is due at least in part to the fact that the wire is connected directly to the ring heater **60** and passes thru part of the hot enclosed die cavity resulting in wire degradation. Further, the cycling/movement of the press apparatus can result in wire breakage due to repetitive flexing. The relatively high temperature at which the ring heaters are operated may also contribute to this problem.

A further problem associated with the use of ring heaters in the context of the pressing apparatus described in the aforementioned patents for press forming a paperboard blank into a food serving paperboard container product involves the significant discrepancy between the wattage ratings of the ring heaters and the wattage needed to perform the pressing operation. To carry out the press forming operation described in the aforementioned patents, a relatively high die surface temperature in the range of about 280° F.–400° F. is typically required. Further, the press forming apparatus must be capable of high speed production. The wattage needed to carry out the process described in the aforementioned patents (i.e., to achieve the necessary temperature on the die surfaces) at the high speed production required for commercial practice is much higher than the wattage for which the ring heaters **60, 62** are rated. The pressing apparatus is typically designed in a way that only permits the use of ring heaters of a certain size and so it is not a truly viable option to simply use larger ring heaters rated at a higher wattage. Given the limitations imposed by the current design of the pressing apparatus, the ring heaters that are capable of being used in the pressing apparatus have power wattage ratings on the order of 300–1200 watts. However, during operation of the pressing apparatus in the

manner necessary for carrying out the process described in the aforementioned patents, the ring heaters are typically run at a much higher wattage, on the order of 1500 watts–5000 watts. Operating the ring heaters at levels such as these that greatly exceed the wattage ratings of the heaters significantly reduces the life of the ring heaters.

The ring heaters **60**, **62** illustrated in FIG. **1** also suffer from certain disadvantages and drawbacks by virtue of the way in which they are constructed. FIG. **2A** illustrates the outer ring heater **60** in cross-section. As seen in FIG. **2A**, the ring heater **60** includes an outer sheath defined by a generally U-shaped portion **74** and a plate-like cover **76**. The U-shaped portion **74** and the cover **76** are commonly made of steel, aluminized steel or incoloy alloy stainless steel. The U-shaped portion **74** includes a bottom wall **84** and a pair of upstanding sidewalls **82** whose upper ends are bent inwardly towards one another. The cover **76** is then secured to these inwardly bent ends of the upstanding sidewalls **82**. Positioned within the sheath **74**, **76** is a coiled wire **78** that is surrounded by a refractory material **80**. The wire **78** is commonly made of nichrome steel to obtain the required electrical resistance. The refractory material **80** is commonly magnesium oxide powder which is compressed during ring heater production.

The difficulties associated with this ring heater construction is that the magnesium oxide refractory material **80** has an affinity for water. During use of the ring heater as the ring heater is heating up, the Incoloy sheath **74**, **76** can expand and distorts so that small spaces are created in the area where the cover **76** is secured to the inwardly bent ends of the sidewalls **82**. Water is thus able to infiltrate into the magnesium oxide refractory material **80** during ring heater cool down. As the ring heater becomes hot during subsequent heating, the water that has infiltrated into the magnesium oxide refractory material will become heated, thus creating steam pressure that distorts the configuration of the Incoloy sheath. Ideally, it is preferred that the bottom wall **84** be as flat as possible to provide the largest contact area with the facing bottom surface of the recess in the die. If water infiltrates the magnesium oxide refractory material and ultimately is transformed into steam pressure that distorts the sheath, it has been found that the bottom wall **84'** of the Incoloy sheath tends to distort and take on a curved configuration as shown in FIG. **2B**. This curved bottom wall **84'** creates a non-flat heating surface which means a significant loss of contact area with the die, thus causing inadequate non-uniform heating. Also, this can significantly reduce the conductive heat transfer to the die. This is part of the reason why the ring heaters need to be operated at a wattage significantly higher than the wattage rating of the ring heaters.

A further difficulty associated with the aforementioned distortion of the ring heater is that it places further strain on the operational rating of the ring heater. Typically, the upper and lower dies in which the pair of nested ring heaters are positioned include respective thermocouple probes that measure the temperature near the surfaces of the upper and lower dies to determine the operating parameters of the respective ring heaters. When the thermocouple detects that the temperatures are too low, the ring heaters are turned on at full wattage for time proportioned periods regulated by a temperature controller. When the bottom wall **84'** of the ring heater distorts in the manner illustrated in FIG. **2B**, heat is not effectively transferred to the die and so the thermocouple senses that the die heating surfaces are not hot enough. This causes the ring heaters to be run at full wattage and higher temperatures for longer time periods, thus creating further operational problems and significantly reducing the operating life of the ring heaters.

The ring heaters typically used in the pressing apparatus for carrying out the process described in the aforementioned patents are typically rated at 240 volts. If it is necessary to use a higher voltage, the length of wire wound in the ring heater can be increased. However, because of the size limitations associated with the construction of the lower and upper dies, it is difficult to use a larger ring heater having an increased amount of wound wire. The other alternative for achieving the higher voltage is to use thinner wire or wire having a reduced diameter and higher electrical resistance. Unfortunately, it has been found that this makes the wire particularly susceptible to breakage or other damage due to the operating conditions associated with pressing apparatus, namely the repetitive pounding and impacting, and the high temperatures.

From the foregoing, it is apparent that the use of ring heaters as the heat source for heating the pressing surfaces of a pressing apparatus that is designed to press form paperboard blanks into paperboard container products presents a variety of disadvantages and drawbacks that have a tendency to reduce the useful life of the ring heaters. This thus requires that they be replaced on an excessively frequent basis. The need for repairing or replacing damaged ring heaters and/or ring heater wires also presents a further significant problem relating to productivity. As noted above, each die set consisting of an upper die and a lower die typically includes three or four ring heaters, two ring heaters in the lower die and one or two ring heaters in the upper die. Typically, there are 4–7 die sets per press so that 4–7 paperboard container products can be produced during each cycle of the press. Thus, there are approximately 12–28 ring heaters per press. If one ring heater or ring heater wire breaks down or fails, the entire press has to be stopped so that the ring heater or wire can be replaced. This of course shuts down all of the other die sets in the press which can have a significant adverse impact on productivity. If the press is operating at full capacity, shutting down the press for even a relatively short period of time necessarily results in a significant reduction in production. If it is necessary to increase production at another facility (or at the same facility assuming the affected press is not operating at full capacity) to make up for the press down-time, it may be necessary to incur added expense (e.g., overtime for the press operators), thus further increasing the costs associated with making paperboard container products.

In light of the foregoing, a need exists for a pressing apparatus that is able to press form a paperboard blank into a food service paperboard container without the disadvantages and drawbacks associated with current apparatus.

A need also exists for such a pressing apparatus that is not susceptible to the excessive amount of operational difficulties and manufacturing downtime as current pressing apparatus.

It would also be desirable to provide a pressing apparatus that provides a more efficient heat transfer to the die to negate the need for operating the heater at an excessively high wattage.

SUMMARY OF THE INVENTION

In light of the foregoing, one aspect of the present invention includes a pressing apparatus for producing a food service paperboard container from a paperboard blank so that the paperboard container possesses an overturned rim provided with folds. The apparatus includes a first die and a

second die that are movable relative to one another. The first die includes a first base and a first platform that is movable with respect to the first base, with the first base having a curved surface for engaging the outer periphery of the paperboard blank. The second die is positioned in opposing relation to the first die and includes a second base and a second platform that is movable with respect to the second base. The second die is movable with respect to the first die and the second base has a curved surface for engaging the outer periphery of the paperboard blank so that the outer periphery of the paperboard blank is pressed between the curved surface of the first base and the curved surface of the second base. A first cast-in heater is mounted within a recess in the first die and includes a tubular heating element comprised of an electrically insulated resistor wire and metal casing or housing embedded within a thermally conductive cast-in material. A second cast-in heater is mounted within a recess in the second die and includes a tubular heating element comprised of an electrically insulated resistor wire and metal casing or housing embedded within a thermally conductive cast-in material.

Another aspect of the invention involves a pressing apparatus for pressing a paperboard blank to produce a food service paperboard container having an overturned rim provided with folds. The apparatus includes a first die having a curved pressing surface and a second die positioned in opposing relation to the first die and having a curved pressing surface. At least one of the first and second dies is movable relative to the other so that the outer periphery of the paperboard blank is pressed between the curved pressing surface of the first die and the curved pressing surface of the second die. At least one cast-in heater is mounted either the first die or the second die to heat the pressing surface of the respective die.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

The features and characteristics associated with the present invention will become more apparent from the following detailed description considered with reference to the accompanying drawing figures in which like elements are designated by like reference numerals and wherein:

FIG. 1 is a plan view of a nested pair of ring heaters typically used in pressing apparatus that press form a paperboard blank into paperboard container products;

FIG. 2A is a cross-sectional view of one of the ring heaters shown in FIG. 1;

FIG. 2B is a cross-sectional view similar to FIG. 2A, but illustrating the ring heater when the bottom wall of the sheath has been distorted;

FIGS. 3A–3D are perspective views of examples of various types of food serving paperboard container products that can be made employing the heater device of the present invention;

FIG. 4 is a cross-sectional view of a portion of one possible food serving paperboard container product shown in FIG. 3A taken along the section line 4—4;

FIG. 5 is a cross-sectional view of a portion of one example of a pressing apparatus in which the heater device of the present invention can be employed;

FIG. 6 is a simplified schematic illustration of the pressing apparatus shown in FIG. 5 illustrating how the heater device of the present invention is mounted;

FIG. 7 is a general cross-sectional view of the heater device according to present invention that is employed in the heating apparatus;

FIG. 8 is a perspective view of the tubular heating element employed in the ter device of the present invention;

FIG. 9 is a plan view of one preferred version of the cast-in heater according to the present invention;

FIG. 10 is a side view of the cast-in heater shown in FIG. 9;

FIG. 11 is a plan view of another preferred version of the cast-in heater according to the present invention;

FIG. 12 is a side view of the cast-in heater shown in FIG. 11;

FIG. 13 is a plan view of a cast-in heater according to the present invention mounted in an upper die;

FIG. 14 is a cross-sectional view of the die and cast-in heater shown in FIG. 13;

FIG. 15 is an enlarged cross-sectional view of the wire connection usable in conjunction with the various versions of the cast-in heater according to the present invention;

FIG. 16 is a graph illustrating temperature data at various parts of a press forming apparatus employing ring heaters during production and shutdown of the apparatus;

FIG. 17 is a graph illustrating temperature data at various parts of a press forming apparatus employing ring heaters during standard heat-up of the apparatus;

FIG. 18 is a graph illustrating temperature data at various parts of a press forming apparatus employing cast-in heaters during production and shutdown of the apparatus;

FIG. 19 is a graph illustrating temperature data at various parts of a press forming apparatus employing cast-in heaters during standard heat-up of the apparatus;

FIG. 20 is a table setting forth the results of a break-even analysis involving the replacement of ring heaters with cast-in heaters in a three ring heater system;

FIG. 21 is a table setting forth the results of a break-even analysis involving the replacement of ring heaters with cast-in heaters in a four ring heater system;

FIG. 22 is a graphical illustration of the analysis results set forth in the tables of FIGS. 20 and 21.

DETAILED DESCRIPTION OF THE INVENTION

The pressing apparatus according to the present invention is specifically adapted for use in press forming paperboard blanks into paperboard container products such as paper trays, plates, bowls, platters and the like from a paperboard blank through the application of heat and pressure to the paperboard blank. U.S. Pat. Nos. 4,721,500, 4,609,140, 4,721,499, 5,088,640, 5,326,020, 4,832,676 and 4,606,496, the entire content of each of which is incorporated herein by reference, describe methods of press forming paperboard blanks into paperboard container products as well as apparatus used to form such paperboard container products and paperboard container products formed by such methods and apparatus. The pressing apparatus of the present invention is designed to be used to carry out these methods and produce these products. Before looking specifically at the heater device of the present invention that is used in a pressing apparatus, a brief description of the general method used to press form a paperboard blank into a paperboard container product will be described.

As seen with reference to FIG. 3A, one example of a paperboard container product that can be press formed through use of the apparatus and method of the present invention is a plate 10 having a substantially flat circular bottom wall portion 11, an upturned sidewall portion 12, and

an overturned rim portion **13** extending from the sidewall. The plate portions **11**, **12**, **13** are formed integrally with one another. It is to be understood that plate shapes other than that shown in FIGS. **3** and **4** can be produced, such as plate shapes similar to those shown in the aforementioned U.S. patents.

As best seen in FIG. **4**, the flat bottom wall portion **11** of the plate extends to about the position in the plate denoted at **15** at which the sidewall **12** begins rising upwardly. The upturned sidewall **12** terminates at about the position marked **16** in FIG. **4** at which the paperboard begins to curve over and down about a smaller radius to form the overturned rim **13** which terminates at a peripheral rim edge **17**.

As described in U.S. Pat. No. 4,609,140, the rim **13** serves a variety of advantageous purposes in the paperboard product. The rim provides an esthetically pleasing appearance, while at the same time, providing a generally lateral area for gripping by the user when carrying the plate. Perhaps most importantly, the rim **13** imparts rigidity and bending resistance characteristics to the plate when the plate is held by a user. As further described in the aforementioned U.S. Pat. No. 4,609,140, the paperboard plate **10** is formed from a unitary flat blank of paperboard stock, either scored or unscored. Thus, during formation of the paperboard container product from the flat blank of paperboard stock, the flat blank of paperboard stock must undergo folding in the sidewall **12** and the rim **13**. The resulting fold lines are shown for purposes of illustration at **20** in FIG. **3**A.

To form the flat blank of paperboard stock into the paperboard plate shown in FIGS. **3** and **4**, a die set or pressing apparatus similar to that illustrated in FIG. **5** can be employed. The die set includes a metal pressware die set defined by an upper die **25** and a lower die **26** which are adapted to press a flat, circular paperboard blank **27** into the configuration of the plate **10** shown in FIG. **3**A. To allow the paperboard blank **27** to be held and subsequently shaped by the die set shown in FIG. **5**, the upper and lower dies are segmented.

The lower die **26** possesses a circular base portion **29** and a central circular platform **30** which is mounted to be movable with respect to the base portion **29**. The platform **30** is cam or pneumatically operated in a conventional manner and urged towards a normal position such that its flat top forming surface **31** is located initially above the forming surfaces **32** of the base **29**. The platform **30** is adapted to be moved relative to the base **29**, with the entire base **29** itself being mounted in a conventional manner on springs or a hydraulic cylinder (not shown). The paperboard blank **27** is adapted to be very tightly pressed at the peripheral rim area during the press forming operation and so it may be difficult for moisture in the paperboard which is driven therefrom during pressing to readily escape. To facilitate the release of this moisture, at least one circular groove **33** can be provided in the surface **32** of the base, with this groove **33** venting to the atmosphere through a passageway **34**. The lower die may also be provided with a spring-biased circular clamp ring **26'** around the base portion **29**, which retracts during pressing, to further control the paperboard blank formation into the final plate product.

The top die **25** is also segmented into an outer ring portion **35**, a base portion **36** and a central platform **37** having a flat forming surface **38**. The base portion has curved, symmetrical forming surfaces **39** and the outer ring possesses curved forming surfaces **40**. The central platform **37** and the outer ring **35** are slidingly mounted to the base **39** and biased by springs or hydraulic cylinder (not shown) to the normal position shown in FIG. **5** in a commercially conventional manner. The die **25** is mounted for reciprocating movement towards and away from the lower die **26**.

During the pressing operation, the blank **27** is laid upon the flat forming surface **31**, generally underlying the bottom wall portion **11** of the plate to be formed. The forming surface **38** first makes contact with the top of the blank **27** to hold the blank in place as the forming operation begins. Further downward movement of the die **25** brings the spring biased forming surfaces **40** of the outer ring **35** into contact with the edges of the blank **27**. This thus begins to shape the edges of the blank over the underlying surfaces **32** in the areas which will define the overturned rim **13** of the finished plate. However, because the ring **35** is spring biased, the paperboard material in the rim area is not substantially compressed by the initial shaping. This is because the force applied by the forming surfaces **40** is relatively light and limited to the spring force applied to the ring **35**. Eventually, the die **25** moves sufficiently far down so that the platform segments **30**, **37** and the ring **35** are fully compressed such that the adjacent portions of the forming surfaces **38**, **39** are coplanar and the adjacent portions of surfaces **39**, **40** are coplanar, and similarly that the forming surface **31** is coplanar with the adjacent portion of the forming surfaces **32**. The upper die **25** continues to move downwardly and thus drives the entire lower die **26** downwardly against the force of the springs or hydraulic cylinder which support the die **26**. At the full extent of the downward stroke of the upper die **25**, the dies exert a force on each other, through the formed blank **27** which separates them, which is equal to the force applied by the compressed springs or hydraulic cylinder supporting the die **26**. Thus, the amount of force applied to the formed blank **27** and distributed over its area can be adjusted by changing the length of the stroke of the upper die **25** or hydraulic cylinder pressure.

FIG. **6** schematically illustrates the upper and lower dies corresponding to the upper and lower dies **25**, **26** described above and shown in FIG. **5**, except that the heated pressing surfaces for forming the paperboard product container are illustrated in FIG. **6** in a simplified manner for purposes of ease in understanding. It is to be appreciated that the upper and lower dies **25**, **26** may have a construction that is similar to that shown in FIG. **5**. It is to be understood that the heater device of the present invention can be used in a variety of different pressing apparatus that are specifically adapted to form food service paperboard container products, including those apparatus described in the aforementioned patents. Thus, as persons skilled in the art will readily recognize, the pressing apparatus in which the heater device of the present invention is employed can have configurations different from that shown in FIG. **5**, depending upon a variety of factors such as, for example, the shape and configuration of the paperboard container product being formed.

The upper die **25** is provided with a recessed area **100** for receiving a heater device in accordance with the present invention. Similarly, the lower die **26** is provided with a recessed area **102** for receiving a heater device in accordance with the present invention.

The heater device **110** used in the paperboard product container pressing apparatus of the present invention is illustrated in FIG. **7** and is in the form of a cast-in heater. It is to be understood that the illustration in FIG. **7** represents an enlarged depiction of the heater device or cast-in heater **110** of the present invention. The cast-in heater **110** illustrated in FIG. **7** is actually sized, dimensioned and configured to fit within the recesses **100**, **102** in the upper and lower dies **25**, **26**.

again illustrate the significant differences associated with the use of ring heaters and cast-in heaters. As seen in FIG. 17, as the start-up of the apparatus is initiated at time zero, the ring heater temperatures rise quickly and significantly, ultimately reaching maximum temperatures of about 875° F. and about 816° F. for the lower die ring heaters and about 794° F. for the upper die heater. In contrast, as shown in FIG. 19, the upper die cast-in heater only reaches a temperature of about 546° F. and the lower die cast-in heater only reaches a temperature of about 453° F. Thus, the cast-in heaters do not heat-up to nearly the same extent as the ring heaters which is an important benefit because as the heater is operated under greater and greater temperatures and for longer and longer periods of time, the heater degrades and its useful life is significantly reduced.

Another benefit associated with the present invention is that cast-in heaters can be purchased with a wattage rating within recommended guidelines, thus resulting in significantly longer heater life. It has been found, for example, that one cast-in heater operated at 2800 watts can replace two ring heaters operating at approximately 4000 watts, thus allowing a possible electrical power and cost savings. In addition, because the connection to the electrical resistive element can be exterior of the cast-in heater, a more even heating is possible and cold spots do not arise. Further, the materials which can be used for the cast-in heater also provides more even heating.

The cost of one cast-in heater is typically more than eight times the cost of one ring heater and so utilizing cast-in heaters in place of ring heaters is not what would commonly be considered a viable solution to the problem of die press downtime. However, by virtue of the unexpected results that have been realized, this significant cost difference has been found to not be an impediment to using cast-in heaters for press forming food service containers.

In one respect, it has been found that operational parameters can be met by using only a single cast-in heater in the upper die and the lower die, thus requiring only two cast-in heaters in each die set as opposed to the typical three of four ring heaters. Replacing three or four ring heaters with two cast-in heaters is also advantageous from the standpoint of producing lower probabilities of failures per die set and press, even if the life expectancy were the same, resulting in significantly less downtime and increased productivity.

The economic or monetary benefits associated with reducing the downtime of the die press(es) is quite significant when considered in the context of commercial production. This is particularly so when it is considered that the die press(es) is typically running around the clock, twenty-four hours a day, seven days a week. Separate and apart from the difficulties that press down time creates with respect to around the clock production, press down time can also create significant problems in the case of seasonal production. Seasonal food service containers can typically only be produced and sold within a relatively small window of opportunity and so reduced output associated with press down time can significantly affect the ability to meet consumer demands for these seasonal products.

The tables in FIGS. 20 and 21 show the results of a break-even cost analysis that was performed with respect to the use of ring heaters in a food service paperboard container forming apparatus versus the use of cast-in heaters in a similar apparatus. FIG. 20 illustrates the analysis results for die sets employing three ring heaters and FIG. 21 shows the analysis results for die sets employing four ring heaters. The analysis was performed based on a normal production output for a given product, an average die press downtime of 45 minutes to replace a failed heater, and considering that the die press is running around the clock, which is the case. Further, the analysis was based on a cost of $40 for each ring heater, a cost of $335 for each of the two cast-in heaters used in place of the three ring heater system and a cost of $390 for each of the two cast-in heaters used in place of the four ring heater system. The analysis is based on consideration of the lost production that occurs each time a heater fails and must be replaced. Thus, assuming a ring heater fails once a month, the analysis considers the amount of production that is lost as a result of that downtime and the cost associated with replacing the ring beater. Considering the significantly greater cost associated with the cast-in heater, the analysis then determines the minimum useful life the cast-in heater must exhibit to break-even.

Referring to FIG. 20, it can be seen that if the ring heaters have a life of one month, the break-even cost for using the significantly more expensive cast-in heaters is 1.8 months. This means that if the ring heaters must be replaced every month, it is possible to use cast-in heaters and break-even so long as the cast-in heaters have a useful life of at least 1.8 months. Similarly, if the ring heaters possess a useful life of 12 months (i.e., the ring heaters must be replaced once a year), it is possible to use cast-in heaters and break-even so long as the cast-in heaters have a useful life of at least 21.9 months. Experience has shown that the useful life of the ring heaters typically varies between a minimum of 2 months and a maximum of 9 months. Thus, the break-even analysis reveals that the use of cast-in heaters is economically beneficial if the cast-in heaters are able to operate without replacement for at least 16.4 months. To date, experimentation and testing have shown that the useful-life of the cast-in heaters in the context of fabricating food service paperboard containers exceeds the break-even point.

The table in FIG. 21 sets forth the results of a similar analysis with respect to a four ring heater system and shows that the break-even point for the cast-in heaters is even less than in the three ring heater system. FIG. 22 is a graph of the results set forth in the tables of FIGS. 20 and 21.

In addition to the foregoing, there are also other significant advantages associated with the use of cast-in heaters in accordance with the present invention. For example, cast-in heaters have significantly lower heater surface temperatures during heat up and production than in the case of, for example, ring heaters. Also, the maximum heater temperatures for the cast-in heater during standard die set heat up is on the order of about 200° F.–800° F. lower than ring heaters. Further, cast-in heater temperatures during production of food serving paperboard plate products are on the order of about 150° F.–600° F. lower than ring heaters. It is also possible to realize electrical cost savings with the use of cast-in heaters due to their lower wattage and more efficient thermal transfer to the die set.

Also, because the wire heater connection can be made exterior of the cast-in heater, wire breakage due to degradation of the wire from excessive temperature is not likely to occur.

In addition, because cast-in heaters are not susceptible to many of the problems discussed above that are associated with the use of ring heaters in pressing apparatus that press form paperboard blanks into food serving paperboard container products, the cast-in heaters have a significantly longer useful life. This means that cast-in heaters need not be replaced with nearly the same frequency as ring heaters, thus advantageously reducing the down-time of the pressing apparatus and the resulting loss of product and profit potential.